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AN EXPEDITION

TO

THE YUKON DISTRICT

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THE
NATIONAL GEOGRAPHIC MAGAZINE

AN EXPEDITION THROUGH THE YUKON DISTRICT.

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CONTENTS.

Introduction

An expedition in the interest of a syndicate of newspapers was organized in the spring of 1891 by Mr Frederick Schwatka for exploring portions of the Yukon basin in the British Northwest Territory and Alaska, particularly the region lying north of the St Elias mountains. A request was made to the director of the United States Geological survey for a geologist to accompany the expedition, and it was the good fortune of the writer to be detailed for that duty.

Under the conditions of travel only a hasty reconnoissance of the region traversed was possible, but as little has been known of it geologically or otherwise that such observations as were made possess a value out of proportion to their completeness. It is the object of this paper to give in systematic form the main facts of scientific interest observed during the journey. A full account of the journey itself, which is not without interest, cannot be given here, but will appear elsewhere through its appropriate channels. Enough of the narrative will be included, however, to indicate the route and means of travel and something of the conditions under which the scientific observations were made.

Mr Schwatka's original plan was to go over Chilkoot pass and down the Lewes, following the regular miners' route to the interior; but on reaching Juneau, at the request of the citizens, backed up by their substantial assistance, it was decided to go in by way of Taku river, with a view to determining whether a trail for pack-animals could be constructed over that route.

Considerable information of an indefinite sort was available concerning the country to be traversed before reaching Lewes river. The pioneers of the Western Union Telegraph company crossed the upper portion of the Taku basin in passing from the Stikine to the Lewes, but the map which resulted from their explorations is only a very crude approximation to the topographic facts, and must have been drawn largely from memory.

Dr Dawson obtained from a prospector named Boswell some information concerning Teslin river and lake Ahkton which he embodied in the map accompanying his report on the Yukon district. The location and form of the lake proved to be remarkably accurate, though the regularity of the topographic

features of the region is such that a clear idea of their relations is easily obtained even without instruments.

The whole of the route from Taku inlet to the Lewes was traversed in the spring and summer of 1887 by a party of eight miners, among whom Mark Russell, a member of our party, was a leading spirit. They started from Juneau before the ice was out of the river, hauling their outfit on hand-sleds so long as the snow lasted, and then packing them. It required eighty days to reach the lake, where the party built a number of boats. After prospecting the Nisutlin and other streams on the eastern side of Atklen valley they went down the Teslin and back to the coast by Lewes river and Chilkoot pass. This is an example of the many unheralded expeditions which the Alaskan prospectors have carried out, facing dangers and privations which appear incredible to one who is not familiar with the men themselves. Less arduous or novel expeditions have brought fame to explorers better versed in the art of advertising than these unassuming miners. Unfortunately, however, geography is but slightly the gainer from the work of the prospector, since he usually has neither the training nor the inclination to use instruments even if he should be supplied with them, which is rarely the case, and ordinarily the map which he draws from memory, unassisted by notes of any sort, is not a model of accuracy.

At the head of Taku inlet a "track survey" was begun and carried continuously to the mouth of Teslin river, where it connected with the line surveyed by Mr Ogilvie in 1887. The instruments used were a prismatic compass for determining direction, and a sextant for latitude. Distance was obtained during the boat journey on the Taku, lake Atklen, and Teslin river by time and eye estimates, and on the portage between Taku river and the lake by pacing. Altitudes were determined from the mean of four aneroids with synchronous readings of a base barometer at Juneau, for which we are indebted to the kindness of Mr E. S. Willard. The route was plotted in the note book and relief indicated by sketch contours; all prominent points within sight along the line of travel being approximately located by compass bearings. While such a survey does not, of course, possess the precision of an instrumentally measured line, still, when carefully executed, it represents the character and relations of the topographic features of a country with a fair degree of accuracy.

Between Yukon river and the St Elias mountains lies a large area, embracing the whole of White river and its tributaries, as well as the headwaters of the Copper and Tanana, which has been geographically a blank. So far as can be learned it had never been penetrated by a white man, and the lakes, rivers and mountains which appear on many maps are products of the geographer's imagination. Across this unknown region a track survey was made similar to the one already described. Excepting about fifty miles traversed by water, the whole distance of 330 miles from Selkirk on the Yukon to the junction of Chitteenah and Nizeenah rivers was carefully paced; and the two ends of the line being located by astronomic observations, the former by Ogilvie and the latter by Allen, the location of intermediate points cannot be far out of the way.

The portion of our route between the mouth of the Teslin and Selkirk, at the junction of the Lewes and Pelly, had already been twice surveyed, first by C. A. Human, the topographer of Schwatka's party in 1891, and more accurately by Ogilvie in 1887. Chitteenah and Copper rivers had been surveyed by Allen in 1885, so that no continuous survey of these rivers was undertaken though numerous observations were made to supplement those embodied in Allen's map.

Narrative of the Expedition.

Our party consisted at the start of three white men—Mr. Schwatka, the prospector Mark Russell, and the writer—with seven Indians engaged as boatmen and packers for the first stage of the journey. After a few days spent in completing the outfit and waiting for the river to become free of ice, we left Juneau May 25, 1891.

The large two-ton dugout canoe in which we embarked was well adapted for navigating the deep waters of the inlet, but we found it poorly suited to the swift and shallow river. When the wind blew up stream rapid progress was made in spite of the current by spreading two large sails wing and wing, but when the wind failed our progress, by poling or tracking wherever the banks permitted, was painfully slow. Seven days were spent in reaching the head of canoe navigation, eight miles above the South fork and about eighty from Juneau. During this part of the journey little opportunity was afforded for studying the

geology of this region traversed since the boundaries generally kept to the middle of the valley and we usually made camp at night on one of the small islands which separate the river into many channels.

While Taku river is far from being an ideal highway to the interior, still a flat-bottomed steamer of light draft and good power would probably have no serious difficulty in reaching the mouth of the South fork, less than a hundred miles from a point on lake Atlkon which could be reached by steamer from the mouth of the Yukon. The country intervening between these points is practicable for pack-animals with the expenditure of comparatively little labor in constructing a trail. It is probably only a question of time when some better way of reaching the upper Yukon basin than Chilkoot pass will be demanded, and the Taku route is, so far as yet known, the least objectionable.

At the head of canoe navigation our outfit was made up into twelve packs of about one hundred pounds each for the portage of eighty-five miles to the head of lake Atlkon. As there were but six packers, each was obliged to make two trips; so that our progress was extremely slow. The first twenty miles of the portage are in the narrow canyon-like valley of an eastern branch of the river, and the next fifty in broad valleys of the upper Taku basin, from 3,000 to 3,800 feet above sea level. The last fifteen miles are in the densely wooded Atlkon valley among innumerable small lakes and ponds. We reached lake Atlkon June 18, and from this point the Indians were sent back to the coast. It was with a feeling of great relief that we watched them disappear on their homeward journey and knew that we were no longer dependent on their caprice.

Setting up the two portable canvas canoes which had been packed in from the coast, we continued our journey toward the northwest, down lake Atlkon and Teslin river, which forms its outlet. The Lewes was reached June 24 and Selkirk, at the junction of the Lewes and Pelly, four days later. The original plan had been to continue down the Yukon to the mouth of White river and up that stream as far as possible by boat, but the Indians whom we found at Selkirk told us the easier route to the head of White river was overland, keeping southeast of the main river valley; and this route we decided to follow.

A store has recently been established on the site of old fort Selkirk, the Hudson Bay company's post, which was burned by

the coast Indians in 1848. The trader, Mr Harper, was down the river and we found only a couple of Indians whom he had left in charge. These were dispatched up the Pelly to collect the natives in the vicinity and we soon had about forty of them camped around us. Only a few of them, however, were able-bodied men, and it was extremely difficult to persuade these to go with us; and when they had promised it was only to back out the next day. After laboring with them for over a week it seemed that the attempt to secure the necessary packers was hopeless, and we were preparing to go down to the mouth of White river and try the ascent by boat, when the tide was turned by the opportune arrival of a prospector, Frank Bowker. He had come up the river from Forty-mile creek, intending to spend the summer prospecting in White River basin. With him were two natives from further down the river, muscular and willing fellows, very different from the wretched specimens from Pelly river. Bowker's arrival, as he came with authority from Mr Harper, who has great influence over the natives, put new backbone into our enterprise. Five packers were soon secured, who promised to go with us to the country of Nodal, beyond the mountains. Dogs were obtained to carry the remainder of the outfit, from twenty-five to forty pounds being packed upon each in panniers of birch bark or moose skin.

On July 9 our combined party of four white men, eight Indians, and eleven dogs left Selkirk. Our course lay toward the southwest, over the great interior plateau which stretches from the Yukon to the St Elias mountains. The headwaters of Selwyn river were crossed and several eastern tributaries of White river.

The country is very scantily peopled, and although we probably saw most of the natives inhabiting the White River basin they only numbered altogether between fifty and sixty persons. The first party, consisting of six families, was camped on the Nisling, making a fish trap in anticipation of arrival of the salmon, which was anxiously looked for. These Indians are closely related to those living on the Pelly. They are similar in appearance and mode of life, and apparently speak the same language. They have no permanent dwellings, but several substantial log caches were seen, which they use for storing their winter's supply of dried fish and moose meat. The country seems to be fairly well supplied with game, goats on the highest

rocky summits, moose and bear in the river valleys, and reindeer or barren-grounds caribou on the plateau above timber line. Several of the latter were killed by members of our party, and our supply of provisions was also helped out by the dried meat which we obtained from the natives. On the Klaunta was found a second party of Indians, most of whom had never before seen a white man. Obtaining a number of rafts from these natives we descended the river about fourteen miles to its confluence with the Donjek, since both the Klaunta and Donjek were too deep and rapid to ford. The Klutlan was also found to be unfordable, and we were compelled to go around its head and cross upon the glacier from which it flows. Although this was not attended by any special danger it caused great dismay among the Indians, who regard a glacier with superstitious terror.

About twelve miles beyond Klutlan glacier we reached a small stream called the Klet-sun-dek, or Copper creek, coming from a narrow gorge in the mountains. This is where the Yukon Indians have been accustomed to come for supplies of native copper. It was as far as any of our packers had ever been from home and they knew of the country beyond only by report. They refused to go with us further, assuring us that it was quite impossible to get through the mountains at that season since the pass was only traveled by Indians in the winter on snow shoes. Bowker had already come further than he originally intended, so that he turned back with the Indians. It was something over two hundred miles back to Selkirk, and although through an unknown country a considerably shorter distance to an Indian village on the other side of the mountains. Trusting in our ability to reach the latter inside of two weeks, a period for which we had provisions, we decided to push forward. Discarding everything not absolutely essential our packs still amounted to seventy-five or eighty pounds apiece, so that progress was necessarily slow. The weather since leaving the coast in May had been very warm, with little rain except local thunder showers, but from this time until we again reached the coast rain was falling most of the time. As we had no tent, this added greatly to our discomfort.

Leaving the Kletsun, our party now reduced to three, we continued toward the northwest through the densely wooded valley, with the White river on our right and the steep mountain face on the left. At the end of the third day we came out upon

White river, flowing from the south in a deep narrow valley. This we concluded must be the pass of which the Indians had told us, and our belief was strengthened by meeting a high wind, amounting almost to a gale, blowing through from the south. A couple of miles back from its mouth a wall of moraine-covered ice stretched across the valley, the river emerging from a tunnel on the extreme western side. This was undoubtedly the ice which the Indians said it would take us at least four days to cross. As usual, however, their statement was wide of the truth. Crossing a couple of miles of rough moraine-covered glacier with a gradual ascent toward the south, we came to a long stretch of firm white ice upon which walking was a positive luxury after our days of floundering in the deep moss and alder thickets of White River valley. We continued to ascend gradually for about ten miles, directing our course toward a low saddle in the mountains on the south which we supposed to be the pass. Toward evening, however, we were surprised to find the surface of the glacier descending and a little later discovered a deep narrow gorge turning off to the right almost at right angles with our former course. We had crossed the divide, and in a short time were off the ice and camped on a stream flowing into the Pacific. This was the Nizcomh, a tributary of the Chitteneh, or eastern branch of Copper river.

The next four days we continued our journey down the narrow canyon which the stream has cut through the mountain range and encountered the most difficult traveling we had yet found. The vegetation on the southern side of this range rivals in luxuriance that of the coast. Forcing our way through the dense growth of alder and spruce which covers the steep slopes at the base of canyon walls was extremely slow and painful work. A mile in four or five hours was counted fair progress.

At length, after having been compelled to ford the river several times, we reached a point at which it appeared not wholly impracticable for boating, and it was decided to stop and build a boat. Our tools consisted of a very dull axe and our pocket knives, but with these we hewed out a keel and gunwales from spruce saplings and fashioned ribs from willow poles, lashing the structure together with twine unwelled from our pack ropes. Over this frame was stretched the canvas in which our bedding had been wrapped and finally the covering was smeared liberally with spruce gum. In this craft our progress was more rapid and

We were so fortunate as to reach Tanal just as Nicolai was preparing for his annual visit to Low Coast, and after a delay of four days we embarked in a large skin boat manned by ten of his vassals. A couple of days brought us down to Miles glacier, which the river tumbles over a cliff of bare ice some hundreds of feet in height. It is necessary to make a portage here sometimes across both moraine and glacier. Crossing about two miles of moraine covered with a dense alder thicket, we came out upon a bluff ridge of freshly deposited boulders. Immediately in front was a broad expanse of the river, in front of the glacier, which formed an ice cliff rising on the side nearly four hundred feet in height. Here were almost constantly falling with reports like a cannon, huge ice spray high above the top of the cliff. The current of the river sets across the lake toward the front of the glacier, and where it runs up the west it penetrates by a falling mass of ice the wall of the lake, which, with the ground for underlying, would appear to be almost stationary. We learned that we might get past by waiting for a fall on the full rise of the tide and for a wind from the right direction to prevent a passage at right angles. The right moment came after we had nearly given up, and taking flight into the boat we were soon past the dangerous spot, to the extreme relief of Nicolai and his crew. A short distance below we passed the front of the glacier, running within a stone's throw of the lofty wall, and found ourselves at the head of the river delta, with the blue Pacific in sight far to the southward. It required a few days of hard work to make canoes before we had left the mouth of Jarvis, and on that score we had two days' delay, as the canoes, over half the number being too few

We were intending going to Eyak, where two miles of canoneses are hauled on a narrow neck of land between the Copper River and Prince William Sound. We were within a few miles of that place we were met by a native with the report that the Eyak canoneses had closed and the t[illegible]

The report, which we afterwards found to be the [illegible] usual trick to [illegible] us to the [illegible] and [illegible] with [illegible] side. By a piece of our way on [illegible] days' arrival at Eyak about four days. On account of [illegible] day we passed the August mail steamer from the sound by [illegible] twelve o'clock and were obliged to wait [illegible] for the

September steamer. Thanks to the abundant hospitality of Captain Humphrey, of the Pacific Steam Whaling company's cannery, our detention there was rendered far from unpleasant, and the opportunity was afforded of examining this little-known region. Taking passage September 21, on the small steamer *Elsie* from Nushagak we reached Sitka four days later, remaining there with Lieutenant Morton for Puget Sound

Summary

Topographic Data.

The topographic data embodied in the accompanying map are as follows: The coast line from the head of Takli inlet to the mouth of the Takli river, Takli river, lake Takli and Takli river, as surveyed in 1898, which I have already briefly described. The rest of the coast line, which was run with a prismatic compass and estimated distances, from the mouth of the Takli river to the mouth of the Lewis, also was run and plotted by Mr. Lawson. The region from the mouth of the Lewis, also run and plotted by Lieutenant Lyon, from the head of Lynn canal, is from the reconnaissance traverse made by Mr. W. Ogilvie in 1887 and embodied together with Lieutenant's track surveys on the map of a portion of the Yukon district which was published in report on an exploration in the Yukon district, North west Territories, and adjacent northern portions of British Columbia, in 1887, by Dr. George M. Dawson.*

The region embracing the mouth of Lynn canal, the Chilkat river and the environs of Chilkat pass. The known routes in the interior of the region that includes the upper Lewis river, Lake Arkell and Takhoo river are from data furnished to the Census office by Mr. E. J. Glave from surveys made by himself in 1891. Mr. Glave's data from a plane-table survey made by the assistant [illegible] in the region of Mount Dawson, Alaska.†

* Ann. Rep't Geol. Survey Canada, 1887, p. 5 B. See also Bull. Geog. Soc. Phila., Vol. [illegible], No. [illegible], 1898.

† Mr. Glave's report to the Census office, dated [illegible], 1892, can be seen in the Bulletin of the Geographical Society of Philadelphia, Vol. [illegible], No. [illegible], 1898.

The coast from Taku inlet to cape Spencer and also from Icy bay to the western edge of sheet [illegible] is from the general chart of Alaska, number 960, issued by the United States Coast and Geodetic Survey, Washington, 1891. The topography of the region shown on sheet [illegible] between Selkirk, at the confluence of the Pelly and Lewes rivers, and the mouth of the Nizzenah is from my track survey, the greater part of which was in canoe.

The Yukon from Selkirk to the edge of sheet [illegible] is from the sketch survey by Charles A. Homan, published as sheet 3 of map accompanying the report of a military reconnoissance in Alaska, made in 1883 by Lieutenant Frederick Schwatka (Washington, 1885).

Chittenah river and the mount Wrangell region are from the survey made by Allen in 1885, sheet 2 of map accompanying the report of an expedition to the Copper, Tanana and Koyukuk rivers, in the territory of Alaska, in the year 1885, by Lieutenant Henry T. Allen (Washington, 1887).

The coast from Icy bay to Yakutat bay, with the region toward the north and along mount St. Elias, is from the surveys of Kerr in 1890 and Russell in 1891, embodied in the map of the mount St. Elias region accompanying a recent paper on mount St. Elias and its glaciers by Israel C. Russell.*

Orographic Features.

From the valley of Fraser river, in southern British Columbia, the western mountain range of the Cordilleran mountain system [illegible] canal. Here it becomes an interior range, while its former place next the coast is taken by the St. Elias range. The southern Alaskan coast mountains form a broad elevated belt with many scattered peaks, of which a few perhaps have an altitude of more than 8,000 or 9,000 feet, while there is no dominant chain. The southwestern front of the range rises abruptly from the waters of the inland passage, forming a rugged barrier to the interior. A few rivers have cut their channels through the range, and it is penetrated at varying distances by numerous deep fiords. From the head of Lynn canal northwestward the range decreases in altitude and gradually spreads out until it merges into the broken

* Am. Jour. Sci., 3d series, vol. xliii, 1892, pp. [illegible]

elevations are generally smooth and abrupt, and the surface except in the southern and glaciated portions of the region, shows the effect of long continued exposure to the action of subaerial agencies. While rock decay has made little progress so that the surface is practically free from soil, rock disintegration is quite extensively active and the country is thickly mantled with rock debris of varying degrees of coarseness. Projecting through this mantle of débris above and on the gentle slopes, are many rounded pinnacles and towers of rock rendered especially conspicuous by contrast with their snow-covered talus slopes. Surface gradation is greatly retarded by the luxuriant growth of moss which covers practically the entire surface of the country. Decomposition proceeds very slowly under the conditions which prevail, and the water from the melting snow is held by the sponge-like moss, which remains saturated throughout the year but is frozen only a few feet below the surface. Thus, while the soil rich in lower latitudes would quickly be washed away, a large part of the surface is swampy, due to irrespective of slope, thus rendering wherever the material encourages it exploitment by coal to become unpenetrable to water by freezing. The summits of this slow ascent of surface mean age the elevations are not quite the equal of the arctic and alpine regions. The general extension west of Mount Sumner, though not quite so high, is somewhat diversified by a number of high sharp peaks probably of volcanic origin.

Approaching the mountains from the east the traveler ranges the plateau country which is relatively level, having many shallow depressions filled with lakes and separated by rather low rounded ridges. There is, however, no drainage of the plateau and the lakes have no outlets but are fed by the melting snow. The southern part of the interior plateau and the mountains to the south are traversed by a depression in the general trend of the mountains many miles wide and 4,000 feet above sea level. This depression is a valley of Yukon River. Here the slopes are not so steep as those of the mountains, which are very sharp and rugged peaks ranging in altitudes of 7,000 to 12,000 feet. Only the steepest slopes were free from snow and the rugged peaks presented a striking

contrast to the green, snow-covered plateau country toward the north. The range here occupies a belt about eighty miles in width from north to south. Mr Russell saw the same region from the eastern flanks of mount Fairweather, and describes it as "A vast snow-covered region, limitless in its expanse, through which hundreds and probably thousands of barren, angular mountain peaks project. There was not a stream, not a lake, not a vestige of vegetation in sight. A more desolate or more utterly lifeless land one never beheld. Vast, smooth snow surfaces, without crevasses or breaks stretched away to seemingly an illimitable distance, diversified only by jagged and angular mountain peaks."[1]

Tuya range

The Takhu rises to the S. some miles further toward the south, as if owing to a deeply buried channel system which in the lower valley would be altogether concealed. The valley which [illegible] of Takhu lake is from one to two miles wide with steep sides rising in many places almost vertically from 3000 to 5,000 feet. The river, interrupted by many small lakes and low waterfalls in its lower course, flows over a gravel bed, but between the high walls of the valley. Its current is rapid and it is [illegible] to the most great [illegible] of navigation from the [illegible] beyond the mouth of the northern [illegible] forks which may be regarded as approximately at the eastern limit of the Coast range. The steep sides are not everywhere [illegible] but [illegible] from the river, while elsewhere [illegible] are generally [illegible] and [illegible] of [illegible] material. The upper [illegible] of the Takhu is [illegible] valleys from [illegible] feet above sea level, and [illegible] of [illegible] which [illegible] stood at a much lower [illegible] than at present. Similar [illegible] will be [illegible] of many [illegible]. British Columbian [illegible] have been [illegible] by [illegible] Dawson, Dall [illegible] of [illegible] to which [illegible] is [illegible] to [illegible] that the same [illegible] is [illegible] but to a [illegible]

[1] Mount St Elias and its glaciers. Am. Journ. Sci. 3d series, vol. xl. 1890, p. 17.

[illegible] of [illegible] of the [illegible] Mountains between [illegible] with special reference to changes in elevation of the [illegible] of the glacial Period. Trans. Roy. Soc. Canada, vol. viii. sect. iv. 1890, p. 75.

[illegible] of lake Aklen brings up the whole subject of the nomenclature of the Yukon and its tributaries. This subject has received very thorough treatment by Dall, Dawson and Russell, so that the history of discovery in the Yukon basin and the origin of the names applied to the Yukon tributaries need not be discussed here. From a consideration of the physi-[illegible] the basin its main axis must be regarded as [illegible] Aklen [illegible], I can hardly agree with Russell [illegible] ground for disregarding well-established usage, as he has done in continuing the name Yukon up to the lake.* Inasmuch as the river is known to be almost wholly within Canadian territory, the final authority upon the nomenclature must be the Canadian board of geographic names, and as Dr Dawson has given the subject the most thorough consideration I have followed him† with a few minor changes in the most of which he has signified his concurrence. The name *Yukon* is applied to the river from its mouth to Selkirk. The name *Pelly* is continued to what has been called the "upper Pelly," i. e., from Selkirk to its head. The name *Lewes* is applied to the river from Selkirk to lake Lindeman, called the "Yukon" by Schwatka. Finally the river flowing from lake Aklen is called the *Teslin*, that being the native name as determined by Schwatka and Dawson, with the generic portion dropped. Schwatka‡ gives "Tesel hinu," more probably Tes-lin-hinu, and Dawson, "Teslin-too," but "hinu" and "too" are generic terms for river, so it is properly Teslin river. The name *Newberry*, applied to the river by Schwatka in 1883, has never come into general use, and the name *Hootalinqua*, which is commonly used by the miners, was, as Dawson has shown, transferred through misapprehension from another tributary of the Lewes.

The floodplain of Teslin river is something over a mile in width, between high bluffs of silt and gravel which will be more fully described under the head of glacial phenomena.

* Notes on the Surface Geology of Alaska. Bull. Geol. Soc. Am., vol. 1, 1890, p. 1[illegible].

† Report on an Exploration in the Yukon District, N. W. Territory, and adjacent northern portion of British Columbia, in 1887. Ann. Rep. Geol. Surv. of Canada for 1887-88, vol. 3, pt. 1, 1889, pp. [illegible]B.

‡ Report of a Military Reconnoissance in Alaska made in 1883, Washington, 1885, map pt. 1, sheet 4.

The current is from four to six miles per hour and, except for a few sluggish eddies near the lake is quite uniform throughout. The water was exceptionally high in the spring of 1901, as shown, and it is not known to what extent the uniformity and velocity of the current. There are no rapids or riffles which would prevent the passage of a river steamer from the mouth to the head of the lake.

The character of White river above Kluane lake is only partially known. Some prospectors are said to have spent a winter at the fork, about sixty miles from the Yukon, but they could not have failed to penetrate, probably because of the torpid, muddy character of the stream [illegible] difficult to observe physical features and impossible for [illegible] to turn back these slow moving waters.

The White river has been navigated by the writer from the mouth of Beaver creek [illegible] and back to the mouth of the Nisling [illegible] with the river [illegible] and [illegible] with the exception of [illegible] at the head of the Nisling the river [illegible] [illegible] of the stream [illegible] a narrow valley, in which, by [illegible] [illegible] rapids.

For the first seventy miles the White river has only three tributaries worthy of mention. The largest of these, the Nisling, probably rises in the greater part of the [illegible] and [illegible] by the Tatamagouche mountains, which [illegible] the Yukon valley. The Nisling is navigable for [illegible] by the greater part of the year and for many [illegible] the first [illegible] are carried off by the [illegible] of the White river, which [illegible] [illegible] of the mountains [illegible]

[illegible]

[illegible] range from the greater part of the Nutzotin Mountains east of the Lake mountains. There was some question as to which branch should be regarded as the main river and which the tributary, but the western is more direct in the axis of the main valley and is probably also somewhat larger than the Jacobs, although no satisfactory comparative measurements were made. The western branch issues as Scolai pass from the northward flowing lake of Russell glacier. In the first miles of its course lying west of the intermont sag-basin it receives a number of tributaries from the south all of which flow from glaciers. The part of the river in most places consists of several channels, constantly shifting, as they spread over a wide gravel plain which in high water is [illegible] by a thin sheet of coarse sediment and numerous small streams.

Scolai* proves to be a pass not through the range which extends northwestward to the Wrangell group. Its west portal, from which the mountains, three miles to the east, rise in steep western wall, which turns a part of the stream northward into White River, runs a similar course northward the south, so that for about ten miles the pass is filled with ice at least several hundred feet in depth. The altitude of the divide, which is near the northern edge of the range, is 5,400 feet, or about 1,800 feet higher than the upper White River valley. The southern lobe of the glacier gives rise to a [illegible] which at first westward through a steep-sided valley for fifteen miles, and then nearly southward about twenty miles, emerging into the valley between the two divergent mountain ranges already described. At the point where the river makes its sharp bend toward the south it receives from the northwest a tributary which has dammed its waters so as to form a lake several miles in length. Just out of its old channel by the ice, the stream flows a short distance through a rocky point and then plunges into a tunnel in the ice from which it emerges half a mile below. After leaving the mountains it flows nearly westward for thirty miles, [illegible] with the Chisana and the latter stream, [illegible] about fifty miles farther to the Copper river. These valleys [illegible] a rather broad [illegible] valley,

* "Scolai" is the name by which the Copper river Indians, [illegible] known among all the Ahtena tribes

Introduction

these regions was very insignificant when compared with those which are covered with [illegible]. [illegible] the coast, is also very common in the interior [illegible] and decreasing in size with increasing [illegible] from twelve feet in the valleys to a few [illegible] on the higher [illegible] the plateau. The upper limit of the spruce forests [illegible] along the coast at an altitude of about 1,800 feet [illegible] along with the snow line, gradually ascends toward the [illegible]. The higher valleys of the Takhin [illegible] spruce [illegible] altitude [illegible] trees are [illegible] the largest [illegible] over a foot in diameter. This pass, with an altitude of 3,100 feet, is approximately at the timber line [illegible] stunted trees [illegible].

A alder [illegible] trees [illegible] and [illegible] diameter [illegible] the valleys [illegible].

In the White River basin [illegible] timber extending less than [illegible] feet [illegible], while the greater part of the plateau surface is practically treeless. On the [illegible] northern side of the St. Elias mountains [illegible] about 2,500 feet.

In Chitina and Copper river valleys we feel the influence of the coast climate [illegible] vegetation [illegible] more luxuriant than in the valleys of White River basin.

[illegible]

Character of the Investigations. — Any attempt to solve the many difficult problems connected with the geology of the region traversed would presuppose detailed study of large areas. The opportunities afforded by a hasty reconnaissance along a single line of travel are obviously inadequate for solution of these problems, particularly when the greater part of one's energy is absorbed in overcoming the physical obstacles to progress and in making even the crudest topographic map to which to refer the observations.

The most satisfactory information on the hard geology of any portion of this region is that contained in Dawson's report, already cited, on the geology of the Yukon district. Dr Dawson had the great advantage of familiarity with similar rocks and geologic problems from previous study in British Columbia. He was also

[illegible] and schist. The district between the [illegible] and [illegible] rivers is composed almost entirely of white marble and to some extent schist, and is the largest observed area of sedimentary rocks between the St Elias mountains and the Yukon.

Rocks of Scolai Pass.—As already described, two slightly divergent ranges, separated by the Chitina valley, extend toward the west and northwest from mount St Elias. The geology of the northern range is simple. In the walls of Scolai pass, by which the range was crossed, its stratigraphy and structure are magnificently displayed. The rocks are comparatively recent, for the most part Carboniferous, Triassic, and Cretaceous. A bed of limestone about 500 feet thick contains many crinoids and corals, probably of Carboniferous age. Above it are red sandstone and jasper and a great thickness of black shale. Collections of fossils from the limestone and the black shale were made, but after reaching the coast they unfortunately were lost, with the exception of a single small piece of shale. This, however, contained several perfectly perfect impressions and was submitted to Professor Alpheus Hyatt for identification. He says: "The fossils in the shale are clearly the remains of a *Monotis* of a Triassic type, as in *M. subcircularis*, Gabb, a characteristic Triassic form in California. This one seems to be distinct specifically, but is evidently of the same age."

Interbedded with these sedimentary rocks and penetrating them as dikes are fine-grained, greenish amygdaloid lavas forming perhaps half of the whole rock-mass. The structure of the range consists essentially of a broad, gentle syncline, with highly contorted beds on either side.

Excellent examples of typical [illegible] structure were seen in the intensely plicated rocks which form the abrupt northern face of the range. This structure is remarkably well shown in the sides of the gorge from which Kletsan creek issues. The 500-foot stratum of white limestone above mentioned is folded in with dark greenish-black amygdaloid rocks so as to form a double V, the overturned southern synclinal limbs dip southward about 30° and 45°, while the normal northern limbs are nearly horizontal.

This plicated belt on the north side [illegible] about six miles wide, and south of it the syncline in which the beds are practically horizontal (coinciding with the axis of the range) occupies a belt from twenty-five to thirty miles in width.

On the southern side of the range there is a region of disturbed rocks similar to that on the north but somewhat wider and less minutely plicated. The structure is well shown in the lower portion of the Nizzenah canyon, whose walls rise from 2,000 to 4,000 feet vertically above the river. One excellent example of faulting was observed. A bed of white limestone about 500 feet in thickness, probably a continuation of the one in which the fan structure was observed on the northern side of the range, has been broken across and thrust over upon itself a distance of half a mile. Within this space there appear to be two conformable beds of limestone in place of one. The diagram made from in which the fault is displayed on the canyon wall confirms certain theories as to the mechanism of such faults derived from much more obscure phenomena in other regions. Evidently folding, due to lateral compression, had been only slightly developed when a shearing fracture took place across the rigid bed. The fracture did not extend far on either side of the limestone, but the thin-bedded black shales above and below are intricately plicated, having taken up the lateral compression by folding instead of faulting. Apparently the conditions which determined the formation of a fault rather than a series of folds in the limestone were, first, the great difference in rigidity between that bed and the adjacent shales and, second, the presence of a heavy load upon the rocks during the compression.

Nizzenah river, for about seven miles above its confluence with the Chittenah, flows in a narrow canyon with rocky walls from 300 to 500 feet high. For a short distance above the canyon the gravel bluffs are replaced by cliffs of calcareous black shale apparently very recent and only slightly affected by the compression which has distorted the rocks lying on the north. At the upper end of the canyon the black shale contains beds of extremely coarse conglomerate, and is succeeded by black slate and mica schist, the latter containing many small quartz veins. An east-and-west line through the upper part of this canyon appears to be the approximate limit of the little altered rocks forming the northern range.

Rocks of Copper River valley.—Several massive dikes intersect the course of the Chittenah a few miles above its junction with the Copper, forming high cliffs and a number of rocky islands in the river channel. The dikes are composed of a very coar-

[illegible] green serpentine and white veins apparently of calcite. The rocks of the southern range which extends westward from St. Louis differ widely from those exposed in Sixtu pass. About Tuna they consist for the most part of siliceous talcose schist with gray horn[illegible] while granite, which is apparently eruptive. Between Tuna and the coast the prevailing rock is a dark gray limestone or quartz-schist. The [illegible] of gravels along the lower course of Copper river flowing from the eastward are composed largely of igneous pebbles and granitoid gneiss containing no [illegible] of black slate and schist. All the sedimentary rocks between the Chitistone and the coast have been [illegible] roughly metamorphosed, so that their original bedding is wholly obliterated, and no statement can yet be made as to their probable age.

Rocks of Prince William Sound.—From the shores of Prince William sound there is a series of black slates and thin beds of dark brown [illegible]. They are highly [illegible] so [illegible] at a [illegible] angle to the slaty cleavage, which, wherever its [illegible] can be detected, is also [illegible] and [illegible] These gneissic [illegible] often vertical. They bear a strong resemblance to the rocks of the Yukon that are described by Russell,* and it is not improbable that they are the continuation westward of that series. Fossil plants are reported to occur in the rocks at [illegible] on Prince William sound, but none have yet been collected. What the series is perhaps [illegible] Mesozoic or younger, any statement as to the age must be at the present time [illegible] regarded as entirely [illegible]

[illegible]

[illegible] Placer gold occurs in many localities throughout the Yukon basin, though only in a few places has it been found in [illegible] quantity to make profitable working. The most important of these are those along the [illegible] between Teslin and Little Salmon rivers and [illegible] [illegible] of the Yukon in nearly the [illegible] [illegible] Tennyson, [illegible] through the winter

* See [illegible] Mount St. Elias, Alaska. [illegible] Mag., vol. [illegible], [illegible] p. [illegible]

was very high when we went down, they are said to have done well in the latter part of the season

One member of our party, Mark Russell, was equipped with long experience in prospecting both for placer and vein gold. [illegible] as possible revealed anything like an extensive examination, still enough was done to give a fair idea of the resources of the region traversed. While on Wade River bank we also had the benefit of Mr Barker's experience. A few "colors" were found in most of the bars of Wade river which we crossed, but it was all fine gold and afforded nothing which could be regarded as a good prospect. The [illegible] of gold-bearing gravels were even less encouraging. Practically no vein quartz was seen between Selkirk and Scougal pass either in place or among the stream gravels. Along the lower portion of the Dominion trail [illegible] to near the mouth of Copper river white banded quartz occurs in many stringers through the rock, but there is a possibility of this region containing gold-bearing [illegible]

Copper.—As we approach the Indian town known as Copper River proper [illegible] never been ascertained to [illegible] actual examination by a competent observer. The country on White River has also been suspected from the presence of native copper among the Yukon Indians, although they were known to trade with those living on Copper river from whom they might have obtained the metal. The Dog Indians whom we engaged at Selkirk for packers promised to show us the source from which in the past they had secured copper for making arrow-heads and more recently for making bullets, which are still used to some extent when lead cannot be obtained. While still at Selkirk they told us of great masses of copper which [illegible] on a stream called the Klotassin, or Copper creek, [illegible] White river near its source. As we approached this locality, however, the masses of copper rapidly decreased in size, first to pieces as big as a man's head, then of [illegible] size, until by the time we reached the mouth of the river the largest piece we saw was one we thought

Although [illegible] from a distance [illegible] others

face of the Mt Elias mountains, flowing from numerous small glaciers a mile or two back from the several thousand feet above the valley of White river. At a former stage, probably when the glaciers descended to a much lower level, the amount of detritus brought annually over about the mouth of the gorge. This newest of gravel is now being cut away and the lower portions of the bed rock contain no small nuggets of native copper are found. The second to the only locality for native metal known to the Indians who were with us, though pieces which had been cut from a larger mass were shown us by those whom we met on Klutlan river. It is not probable, however that any of the broken down fragments are of sufficient size to provide of native copper, since they have very little of the rust and other incrustation on them. A greatly exaggerated idea of the value of the copper was current among the natives of the upper Copper river valley, for the source of the copper on Klutlan creek but without success as we soon reached the snow line, beyond which, of course, further search was impracticable. It appears to have been brought by the Indians from the region toward the south which is still somewhat known and not. It is associated with greenish-black amygdaloid of basaltic and red massive metal pebbles which are abundant, especially at least, those of the conglomerating series of the lake Superior region.

A small quantity of what appeared to be azurite, in veinlets and seed to pebbles, was shown us by the Yukon Indians. They said it came from the country beyond Lenda pass, but we were unable to learn the exact source or how they obtained it.

According to Allen's account, the chief of the Copper river Indians is said to have a piece of native copper great as one of the copper cross in the upper valley between the two main streams, but he did not visit the country. We expected to find an Indian on the Nadahini at the point where it enters from the mountain pass said to be near. In the summer there is plenty of this water, but unfortunately Nadahini and his people were at their winter fishing station, Tanana, and it was too late in the season to return to the copper region which we had passed.

Nevertheless there appears to be a considerable area of beach gravel in good and careful examination to determine commercial amount but the extreme scarcity of access together with the unfavorable climate could hardly reward, at present, the development of its resources.

Volcan de Tuxtla.

Lat. 18° 34' N., long. 95° 10' W.

Volcanic activity in the United States within historical times has been confined wholly to Alaska, and, even there, is somewhat unusual on the part of mountains on the Pacific coast. It has been confined to the southwestern extremity of the territory. The most easterly known crater which shows any activity at present is mount Wrangell. This was observed for seven days during August, 1901, from a vessel at the entrance of Chatanna and Copper rivers. It lies about fifty-five miles nearly east of Cape Yakataga, and only the top of the mountain, a large black cone, appears above the intervening broad snow-covered dome of mount Blackburn. From this cone masses of densely black vapor were constantly rising. At intervals of about half a minute a steady pressure would tear itself to a height of several thousand feet and floating off toward the east, quickly disappear, to be replaced by another burst of smoke from the crater. No illumination of the vapor was noted at any time so far as I could learn from the chief Nicolai, nor any column of fire was ever seen. According to the story of Lieutenant Allen, a scout who spent the winter of 1884–85 at Taral, this volcano was at that time in a state of somewhat violent eruption. He says:

> "The volcano has been very active all the time, but during the most part of each morning and afternoon the columns of steam and smoke rise to the height of two or three thousand feet high in the air. The noise of the explosions must be very great, as we can hear them [at] . . . [a] distance of twenty miles, only a part of the time, however."[1]

It is probable that an active volcano may exist somewhere on mount Wrangell on the upper White river basin, but our information as to the character of the region is so unreliable that many mistakes of the Indians and voyageurs that may right [illegible] mount Wrangell. Some of the [illegible] were seen [illegible] also Wrangell and [illegible] in the St. Elias region lie between Kluane lake and Skolai pass. The [illegible] region, however, could only be inferred, and may present active [illegible].

[1] The Scouts and Alps of Alaska, H. W. Seton Karr. London, 1887, p. 19.

have been concealed from us by the clouds which hung about [illegible]

Recent volcanic activity

The most striking effect of recent volcanic activity in the region is the wide-spread deposit of pumiceous ash, or tufa, which covers the southeastern portion of the Yukon basin. This deposit was first noted by Schwatka on the reconnaissance of 1883. It was more fully described as it occurs on the Pelly and Lewes by Dawson in his report of the Yukon expedition of 1887, and was noted by McConnell in 1887 and Russell in 1888 on the Stikine and Lewes.

It was first met by our party on Teslin river shortly after leaving lake Arkell, and from this point it was met with at nearly all points where the land in cut banks of the river nearly down to the mouth, at the confluence of the Lewes and Pelly. Where first seen the layer of tufa was less than an inch in thickness, and from this it increased to a maximum of nearly or quite four feet in thickness at the Teslin, with an average thickness of two or three feet. The deposit where [illegible] upon the layer of tufa is generally about a foot in depth, but it is sometimes more than this, or less than four feet. A bank, however, probably represents the normal accumulation of soil under the prevailing conditions since the deposit of the tufa.

The first point at which the tufa was noted in the White River basin was about one hundred miles southwest of Selkirk post, on the trail between the Nasina and Donjek, tributaries of White river. It is not possible to trace the deposit continuously over the whole of this country, as no [illegible] for its preservation and [illegible] were seen in the high land interval. A layer much thinner than that upon the lower Lewes and Pelly is found to be widely distributed in the surface soil at elevations of 3,000 feet or more above

In the basins of the Klondike and Indian rivers the tufa does not form a continuous layer as in the Lewes basin, but is probably represented by certain strata of beds of white sand, which were deposited at the time the lake beds were. They are underlain and [illegible] from the portions to be carried and deposited by the river at the present time, except in being somewhat coarser

The original thickness west of the Donjek must have been at least several feet, and the increase is very marked toward the [illegible]. Th[illegible] and forms considerable alluvial fans at the mouths of the ravines closely resembling the cones of snow which form in similar positions. After passing the Kluthern the narrow valleys were found deeply filled with tufa which had accumulated from the steep mountain slopes. From the divide the upper White River valley was seen stretching forty miles to the westward, and appeared almost completely covered with drifts of snow. On reaching the valley the drifts proved to be tufa, which forms a deep mantle over the country north of the St. Elias mountains, and for twenty miles west of the Kluthan forms a desert of drifting snow-white sand into which one sinks from four to twelve inches in walking. A scanty growth of dwarf alder and blueberry bushes has gained a precarious foothold in some places, and a few stunted spruce trees grow in protected spots along the streams. The tufa extends up the mountain sides on the south, covering every surface where the slope is not too steep for it to lie, and finally merging with the eternal snow, which begins about 1,500 feet above the valley or 6,000 feet above sea level. The valley was covered with a sheet of glacial drift before the deposition of the tufa, and in consequence the drainage is very imperfect. Many small lakes and ponds, usually without outlets, are scattered over the surface.

The greatest observed thickness to which the tufa deposit attains is between 75 and 100 feet. This was seen on the western bank of the Klutlan, where there is no reason to suppose that its original thickness has been increased at the expense of surrounding regions except, perhaps, by wind drift.

Toward the upper end of the valley the thickness of the deposit decreases very rapidly, and at the entrance to Skolai pass, less than forty miles from its maximum, it appears as a narrow white streak in the freshly cut river banks, exactly as it does along the Lewes and Pelly, 300 miles to the eastward. The deposit also appears to decrease in thickness rapidly toward the north, and there is no indication of any considerable [illegible] the gentle slopes of the valley or on the mesas [illegible] White river.

The gradual increase in thickness of the deposit from east to west is accompanied by an increase in the size of the fragments

As described by Dawson * from the Yukon, "It is a fine, w
many materials * * * containing shards of volcanic glass.
* * * the greater part of which has been drawn out into
capillary threads frequently resembling the substance known as
'Pele's hair'" where first noticed between the Nation and
Klondike. It had the appearance of sand, and results from the
decomposition of a fine or coarsely crystalline marble, the individual fragments being from .01 mm to 1 mm in diameter. The average dimensions increase to the westward, and in the Klondike valley the deposit contains many fragments of white vesicular pumice from two to ten centimeters in diameter, though the greater part is much finer, the ash from 1 mm to 1/10 mm in diameter. Nothing in the character of the deposit or the bombs was seen to indicate, though the pressure may have been overlooked.

Taking the approximate limits of the deposit, as mentioned by the Yukon by Mochenzie, on the Peily and Lewes by Dawson, and on the Tesling at Selkirk just by the writer, it will be seen to cover an oval area, with its maximum thickness near the western extremity. The oval area, which is [illegible] is about 80 miles from east to west and [illegible] nearly or almost fifty square miles. Assuming the deposit to be in the form of a flat cone with the above base and a vertical height of one fifty feet, its volume are found to be [illegible] material.

From the facts of the case, as above stated, a fairly safe inference may be drawn as to the source of the deposit. The explosive energy with which pulverized ash was probably ejected, and the fact that no part of it is known to have fallen on the Klondike glacier. As already stated, it was impossible to tell whether there are any present volcanic activity in this region. The only known peak, of which the top remained hidden by clouds, was pointed out by the natives as having some unusual characteristics of which they seemed to stand much in awe. The name by which they called it was Not-zah-ah, meaning, as near as I could make out, "white of mouth," but, owing to native reserve and lack of interpreter it was impossible to obtain any satisfactory information concerning the mountain. Mount Wrangell has been suggested as the source of the ash.

* Report on an exploration in the Yukon district, N. W. T., and adjacent parts of British Columbia, 587. Ann. Rep. Geol. and Nat. Hist. Survey Canada. Montreal, 1887. [illegible]

green to milky white." This turbidity has been attributed to the general source of the river, but glaciers could scarcely supply such an enormous quantity of mud unless acting under peculiar circumstances. The presence of this great deposit of unconsolidated material, which is now ground up by the present stream, affords a ready explanation of the turbidity of the water. The highly vesicular character of the tufa permits a much larger amount of it to be held in suspension than of sediment derived from compact rocks.

Tertiary volcanic activity

Evidences of volcanic activity geologically recent though very much more remote than the eruption of the tufa deposit, is somewhat abundant. Perhaps the most striking example of such activity is seen in the beds of lava at the junction of Pelly and Lewes rivers. This lava flow took place after the river valleys had been eroded perhaps below their present levels and extended entirely across the valley. The river has since cut through the barrier, leaving only a few fragments of the basalt resting on the granite on the west side of the channel. The lava flow probably came from two or more craters; one plainly two miles north of Selkirk still retains the form of a symmetrical cone, and according to the native account it has at still later epochs been a vent, probably contributing the crater. A second vent was that which lies on the western side of the Yukon about four miles northwest of Selkirk. Between this vent and the present Black vesicular lava was seen at many points, and much of the upper part of White river are broad areas which appear to be formed of black lava. These are all probably of Tertiary age.

Glacial Phenomena

Existing Glaciers

So far as known the existing glaciers of Alaska are confined to [illegible]. A few [illegible] and lies in the coast belt, this is not the sole or chief reason for the notable absence of glaciers in the interior, except in so far as climatic conditions are thereby modified. There are [illegible]

snow disappears in summer, although they have an altitude of from 6,000 to 7,000 feet and a mean temperature much lower than any portion of the southern coast. The explanation must be found in the very much greater precipitation and prevalence of clouds along the coast than in the interior.

The glaciers farthest removed from the coast are those flowing from the mountains of the Wrangell group, where the moisture-laden winds of the north Pacific are able to pass up the Copper River valley and across the coast range, which is here much lower than toward the east.

Four considerable glaciers descend to or nearly to tide level on Taku inlet and river, though only Taku glacier, entering the head of the inlet, discharges bergs. A few miles up from the mouth of the river are two glaciers which come down into the valley nearly opposite to each other. Neither quite reaches the river, but, like the Norris* glacier on the inlet, they spread out into fan-shaped expansions with low wooded ridges of morainic material in front. Along the steep sides of the river valley above these glaciers a slight but distinct terrace has been cut about 150 feet above the river. It is probable that Wright† glacier pushing across the valley to its northern side, dammed the stream for a short time after the main valley was clear of ice. Above Wright glacier only a few small masses of ice or glacierets [illegible] in the Taku basin, their position [illegible] summits. No parts of the interior plateau, either in the Taku or Yukon basins, carry glaciers, and probably very little if any snow remains the whole of the year between the Coast and Cassiar ranges, though much of the surface is fully 3,000 feet above the snow line at the coast. The reason for this rapid rise of the snow line toward the interior is the dry climate, with short but hot summers prevailing throughout this region. In like manner the high plateau east of White river is wholly free from summer snow, and the first glaciers seen in the Yukon basin were those flowing northward from the St. Elias range. Klutlan and Donjek rivers are reported by Schwatka to head in glaciers, but these were not seen, since they lay too far east of the route traveled. Three large glaciers flow into the White River basin west of the Alaskan boundary, and [illegible] crossed while following the southern bank of the upper White river

* Named in 1890 for Dr Basil Norris, surgeon United States Navy.

† Named by the writer for Professor G. F. Wright of Oberlin College.

[illegible]

these the eastern appears to be retreating much more rapidly than either of the others; but this eastern branch probably has its source in the same basin as the Frederika glacier, and it seems not improbable that by some means the drainage of the basin has been diverted from the western to the eastern outlet, thus causing the rapid retreat in the former glacier and advance in the latter.

The large trunk glacier above referred to draws from the mountains forming the eastern members of the Wrangell group. After the union of its three branches the combined stream occupies the valley of the Nizzenah for about six miles, crowding the river out of its channel and forming a long filled lake above the ice barrier. Its great volume, together with the distance which this glacier pushes down into the valley, indicate an increased precipitation due to proximity to the Copper River valley, through which pass the warm winds from the ocean.

No glaciers flow into the Chittenah valley from the ranges on either side, though all the upper portions of the Wrangell group are snow covered and doubtless the higher recesses are filled with ice. Several large glaciers flow into the Copper River valley from the coast range, although its altitude is not so great as that of many portions of the interior plateau which is entirely free from summer snow. The largest of these coast range tributaries of the upper river are Miles and Childs glaciers, named by Lieutenant Allen in 1885. Several others of considerable size higher up the river do not appear on Allen's map, probably because he passed up the river while the surface was still covered with snow. Miles glacier is quite comparable in size with those of the St. Elias region and is formed under essentially the same climatic conditions. It is evidently retreating at present, and the river spreads out in a lake-like expansion along its front in a part of the general channel from which the ice has receded. This expansion of the river is about three miles wide, and one side is formed by the glacier front, a cliff of ice 300 feet above the water and over five miles in length. Although the ice no longer reaches entirely across the valley, there remains a heavy lateral moraine, indicating its former position and damming back the river as already described. The fact that the river has cut only part way through the moraine indicates a very recent recession of the glacier.

Former Extension.

In common with other parts of the coast region, the Taku basin shows signs of intense glaciation from the westward-flowing portions of the Cordilleran ice-sheet. Evidence of this ice-flow is found in the polished and striated rock-surfaces on many islands, where many are due to the action of a glacier more powerful than the river-valleys can supply. The evidence of an ice-sheet here is more abundant, however, towards the upper part of the basin. Thus, on a spur of the high plateau east of the Face of Taku Floe, blue clay and stratified gravels were seen 1,400 feet above the river. The movement of the ice in the greater portion of the Taku basin was apparently in the same direction as the present drainage. The high broad valleys of the upper Taku branches are amply filled with a mantle of boulder clay and gravel. In most cases this is not merely a comparatively thin sheet of drift, but also many narrow ridges occur from ten to fifty feet in height, with their long axes in the direction of the present valleys. These, however, probably mark a phase of deposition by a greater ice-sheet, and were not, so far as they afford clues, formed during the maximum glaciation. More definite indications are afforded by the transportation of boulders. From the head of Atlin Lake eastward on the Taku for a point nearly half way across to Arakan valley, a succession of boulders were observed composed of a porphyritic granite containing large porphyritic crystals of pink hornblende. At this point there was found to be a change of basic constituents of the granite, and no boulders of this rock were seen to the northeastward. At the head of the divide between the two lakes which would first indicate the direction of the ice-movement, there is seemingly no doubt that it was toward the northwest, as it certainly was in Atlin valley.

Some deposits of true boulder clay occur at various points along the lake, and a single occurrence was noted on the Teslin river about five miles from its mouth. Among the many lakes in the upper part of the valley are ridges and mounds of rounded boulders and gravel, which, with terraces of the same material about the head of Atlin, were evidently deposited by

much as appears at present, may somewhat larger, the waters
ber e held by the dam of silt which had been laid down in front
of the ice

Having in mind the conclusions of Dawson, McConnell and
Russell as to the northern limit of glaciation in the Yukon basin,
evidence on that point was carefully sought in the plateau region
southwest of Selkirk. For the first one hundred and twenty-
five miles the evidence was wholly negative. No sign of glac-
iation was seen, and the bed rock everywhere well calculated to retain
the marks of ice action. The stream gravels consist of a very
small number of rock species, and on following up a stream to its
head the source of each was usually found showing that no
foreign material had been brought into the basins. While in
general the surface contours are smooth and flowing, these are the
result of long-continued solar and frost disintegration, and gener-
ally the surface rock is deeply buried beneath great accumu-
lations of fragmental debris, though occasional sharp pinnacles
and towers of rock project from the sea with talus slopes. Had
this region been subjected to the action of an ice sheet during
the glacial epoch, not only would the greater part of the rock
débris have been removed but the projecting pinnacles would
have been planed down to rounded knobs which would still
retain polished and striated surfaces.

When Nordenskiöld river was crossed its broad valley is filled with
a deposit of coarse gravel and bowlders from three feet
in quantity and variety it was inferred that the stream had its
source in a drift-covered region. The first undoubted erratic
found, however, was found on the divide between Sixtymile and
Indian rivers, where the northern edge of a sheet of bowlder
clay was passed. From this point southward the character of
the surface shows a marked change. It is no longer composed
of the fragments of one or two kinds of rock occurring in place
near at hand, but rather of many varieties confusedly mingled
with clay and sand. The drainage system is imperfectly adjusted
to the topographic surface, so that wide valleys carry small
streams, and large streams like the Klondike and Hunker flow for
many miles in directions at least through narrow valleys
The area which has left its record in this sheet of bowlder clay
was probably a continuous glacier field fed by streams coming from
the south through narrow valleys now occupied by Klondike
and Hunker rivers. These valleys do not appear to have been

[illegible]

[illegible]

APPENDIX

CRYPTOGAMS COLLECTED BY Dr. C. WILLARD HAYES IN ALASKA, 1891.

BY CLARA E. CUMMINGS

LYCOPODS

Lycopodium complanatum, L. Taku, June. A small form without fruit.

MOSSES

Sphagnum cymbifolium, Ehrh. Prince William sound, September.

Sphagnum acutifolium, Ehrh., var. *purpureum*, Schimp. Taku, June. A matted form.

Dicranum fuscescens, Turn. Prince William sound, September. On decayed wood.

Dicranum scoparium, Hedw. Prince William sound, September.

Dicranum majus?, Turn. Prince William sound, September. Sterile.

Tetraphis pellucida, Hedw. Prince William sound, September. Male plants, on wood.

Mnium punctatum, Hedw. Prince William sound, September. Sterile.

Aulacomnium palustre, Schwaegr. Taku, June.

Polytrichum commune, L. Prince William sound.

Polytrichum juniperinum, Willd. Taku, June. Male plant.

Hypnum (Plagiothecium) undulatum, L. Prince William sound, September. Sterile.

Hypnum circinale, Hook. Prince William sound. Sterile.

Hypnum (Pleurozium) splendens, Hedw. Prince William sound. Sterile.

Hypnum (Hylocomium) loreum, L. Prince William sound. Sterile.

HEPATICÆ

Frullania (probably a new species). Prince William sound, September.

Diplophyllum taxifolium, Dumort. Prince William sound, September.

Lepidozia reptans, L. Dum. Prince William sound, September.

Scapania dicksoni, Steph. Prince William sound, September. A species not before reported in the American collection.

Mylia taylori, S. F. Gray. Prince William sound, September.

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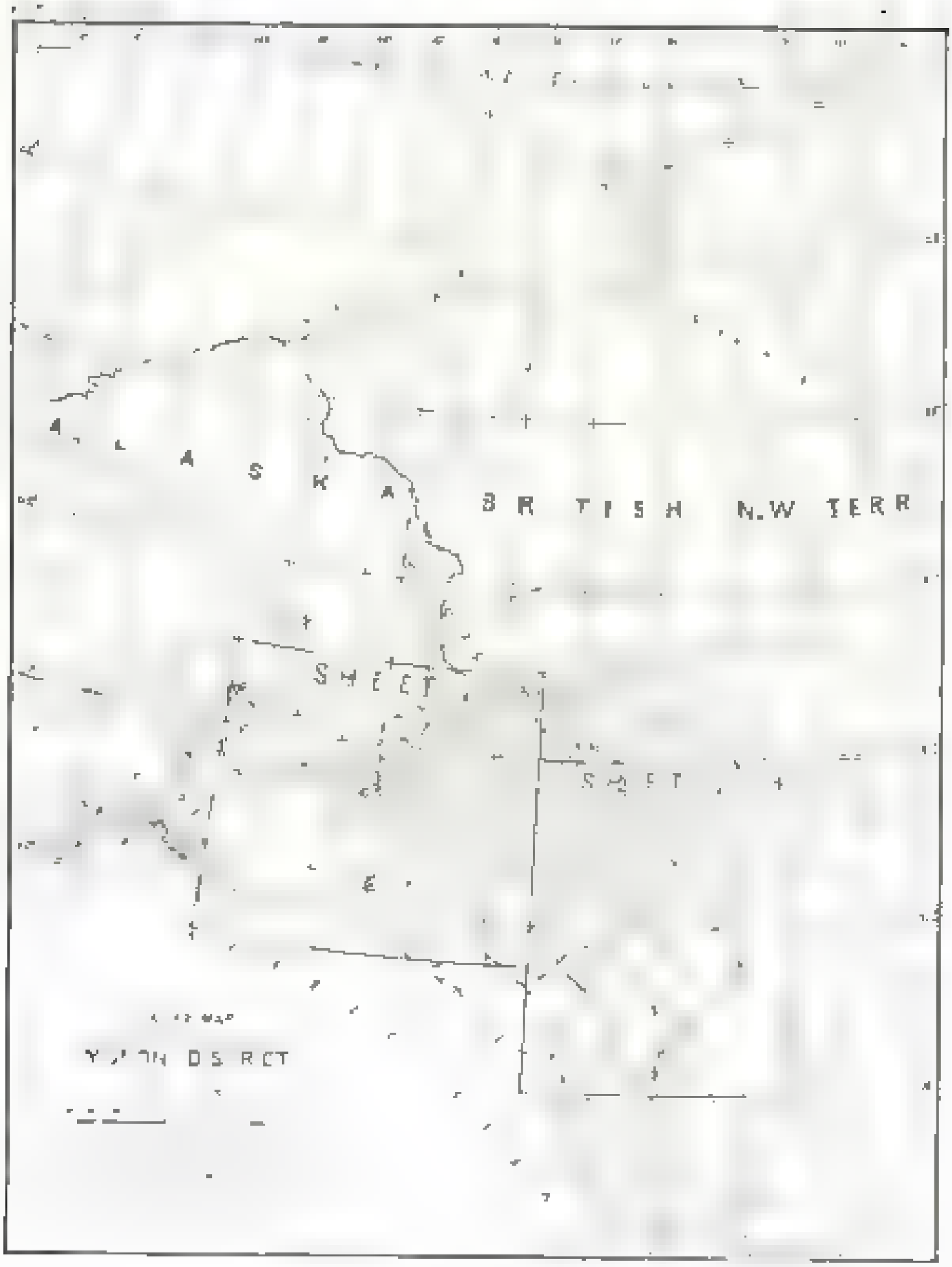
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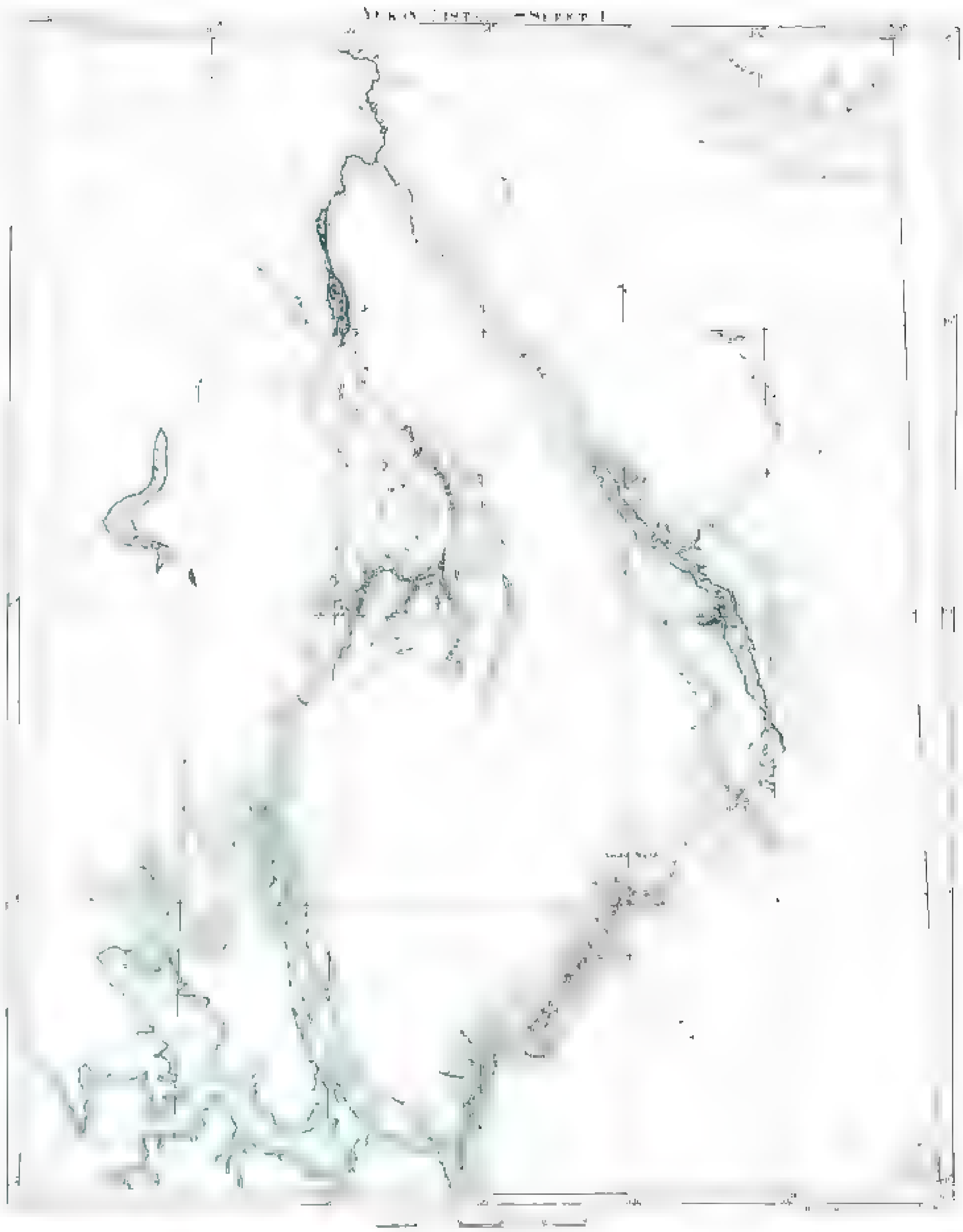

Yukon District—Sheet 2.